



RCA INSTITUTES

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Technical Lesson 33

CONSTRUCTIONAL DETAILS OF THE RCA INSTITUTES

A.C. SCREEN-GRID RECEIVER

General Topics. In our previous lesson the principles of design and practical operation of an a-c operated screen-grid receiver were discussed and many problems which enter into the design were explained. Keep these principles in mind because you will now be shown how to apply them to a typical receiver and, also, you will learn how to actually build the receiver and adjust its radio-frequency circuits for maximum selectivity and sensitivity.

The parts named in the following list include every important piece of equipment necessary for the construction of your screen-grid receiver.

- 1 Push-pull Input Transformer.
- 1 Push-pull Output Transformer.
- 1 Power Transformer. (This consists of 5 separate windings)
- 3 R-F Transformers.
- 3 R-F Choke Coils.
- 1 Dual 30-henry Choke. (This consists of 2 Filter Reactors)
- 1 Headset. (Phones)
- 4 UY Sockets. (For tubes with 5-pin bases)
- 3 UX Sockets. (For tubes with 4-pin bases)
- 1 400 ohm Resistor. (UY-224 Control Grid Bias Resistor)
- 1 750 " " (UX-245 Grid Bias Resistor)
- 1 1000 " " (1st A-F Grid Bias Resistor)
- 1 8000 " " (Plate Supply Resistor)
- 1 40,000 " " (Detector Plate Coupling Resistor)
- 1 40,000 " " (Screen-Grid Voltage Drop Resistor)
- 1 2.0 megohm " (Detector Grid-leak Resistor)
- 1 250,000 ohm " (1st A-F Amplifier Grid-leak)
- 1 6000 ohm Potentiometer. (Volume Control)
- 2 0.01 mfd. Condensers.
- 3 0.1 mfd. Condensers.
- 1 .00025 mfd. Antenna Condenser.
- 1 .00025 mfd. Detector Grid Condenser.
- 1 3-gang Tuning Condenser. (Each condenser .00035 mfd.)
- 1 Condenser Block. (This consists of 6 fixed condensers)

Miscellaneous Parts:

- 1 Double resistor mounting.
- 1 Single resistor mounting.
- 3 R.F. Coil shields with mountings.
- 3 Coil mounting brackets.
- 2 Complete screen-grid clips.
- 2 Shielded wires for screen-grid clips.
- 2 Switches.
- 1 Dial for tuning.
- 1 Terminal strip.
- 1 Drilled panel.

Also, there is an assortment of rubber covered and colored wire, wood screws, hex nuts and soldering lugs.

Additional items not furnished with the kit and to be obtained by the student are as follows:

- 2 Vacuum tubes of the UY-224 type.
 - 2 Vacuum tubes of the UY-227 type.
 - 2 Vacuum tubes of the UX-245 type.
 - 1 Rectifier tube of the UX-280 type.
- Loudspeaker. (Either a dynamic or magnetic type speaker may be used with this set, but better results will be obtained with the use of a good dynamic type.)
- Antenna and ground equipment.
- Soldering iron and sufficient rosin-core solder.
- Baseboard 12" wide by 28" long by $\frac{3}{4}$ " or 1" thick.
- This should preferably be of plywood to avoid warping.

If UX or UY-type tubes are not available you may use any tubes of a similar type providing, of course, they are in good operating condition. The surest way of testing a tube, or to check its condition at the time of purchase, is to insert the tube in the proper socket of some receiver which is operating and tuned to a broadcasting station. A tube which is O.K. will give satisfactory reception. It is very important to use two 245 power tubes having nearly the same characteristics, that is, they should be matched in order to work efficiently in push-pull relation.

The wires, insulators, clamps and other parts comprising the antenna and ground equipment may be of any standard make. It is suggested that you erect an antenna not to exceed 50 feet in length to obtain best results. If an antenna of this dimension is used it should be connected to the "S. ANT." (meaning short antenna) terminal of the receiver. A longer antenna than the one just suggested may be required in conjunction with your receiver if it is remotely located from broadcasting stations. The longer antenna is often necessary in order to pick up sufficient signal strength for satisfactory reception and in this case you should be careful to connect the antenna lead-in wire to the "L. ANT." (meaning long antenna) terminal. This connection places a small fixed condenser of .00025 mfd. capacitance in series between the antenna lead and receiver circuit and thus allows the receiver to maintain its selectivity even with the use of a long antenna.

This constructional lesson is divided into seven parts as follows:

- Part 1. Constructional Details.
- " 2. Wiring of Filament and Heater Circuits.
- " 3. Wiring of Plate and Audio-Frequency Circuits.
- " 4. Wiring of Radio-Frequency Circuits, which includes Antenna, Grids, and Cathodes.
- " 5. Wiring of Power Supply Circuits, consisting of Rectifier, Filter and Power Transformer.
- " 6. Practical Operation of Screen-Grid Receiver.
- " 7. Line-Up Adjustments of Radio-Frequency Circuits.

PART 1

CONSTRUCTIONAL DETAILS. Refer to Figures 1, 2 and 3.

Your first step in the construction of this receiver is to unpack all of the parts carefully and then proceed to identify them according to our illustration in Figure 1. This drawing is a plan view of the set showing pictorially the general relation of the parts. The parts are not only named but their electrical values, or rating, are given in many instances. It surely will be to your advantage to learn the name of every part before you begin the actual construction work.

The next thing to do is to study very carefully the dimensional plan-view drawing in Figure 2. The exact location of the parts as you will assemble them on the base board is made clear by this drawing. The measurements, as given, indicate the distances between the centers of the different parts and after placing them on the board according to this lay-out it will be but a simple matter to screw them down securely in position. We have arranged the parts in a particular way so that the circuits may be traced out easily for the purpose of instruction and, also, to obtain the most efficient results. Some of the smaller pieces come quite close to one another and, therefore, you must be careful in your measurements and not permit any parts to touch.

Let us repeat that the various parts must be mounted on the board according to the arrangement as shown on the dimensional diagram in Figure 2, because an incorrect placement of any part may have a bearing on the operation of the receiver.

After you finish mounting the parts on the baseboard then proceed to assemble the two panels which are to be screwed to the front of the board. One panel is the narrow terminal strip fitted with suitable connections for attaching the antenna lead-in wire, the ground wire, and the leads from the loudspeaker.

The other panel is comparatively large and is drilled with holes for mounting the volume control resistor and the "OFF-ON" switch. A small hole in the center permits the shaft of the gang condenser to pass through. The tuning dial, often called station selector, is put on the end of this shaft after the gang condenser and panel are in place.

In regard to the two switches it must be mentioned that although they are constructed alike mechanically and can be used interchangeably they are not mounted in the same way, as we will now explain. The "OFF-ON" switch is mounted together with its name plate on the large panel and this should be done in only one way, so that the words OFF and ON can be read properly. However, in the case of the other switch, the metal name plate that is furnished with it is not used and, hence, only the switch unit itself is mounted on the terminal strip in the hole drilled for that purpose, with the switch being turned in a position that makes it relatively upside down to the "OFF-ON" switch. The correct position is easy to determine because an examination of the switches will show that each has a grooved slot running along the threaded portion. If you have the groove in the down position for the "OFF-ON" switch and in the up position for the "LOCAL-DISTANT" switch

then the latter will function correctly in the circuit. It is obvious that the latter switch does not use the metal name plate, as stated before, because the words LOCAL and DISTANT are engraved on the front of the strip.

Before wiring the set note that soldering lugs must be placed over the terminals, or screws of various parts. Some parts are already equipped with lugs but those parts without lugs and with binding posts, or screws, should have the lugs attached to them. You can readily determine for yourself just where to put soldering lugs since every connection in the set must be a soldered one. The only wires that will not require soldering are the antenna lead-in, the ground connection and the leads from the loudspeaker, and all of these are attached to the proper terminals on the terminal strip only after the set is completely assembled and ready for practical operation. Two lugs should be screwed on each switch and connections to these made as suggested later. If one or two of the soldering lugs on the back of the terminal strip seem to be too close to the 1st r-f socket you can bend them slightly upward.

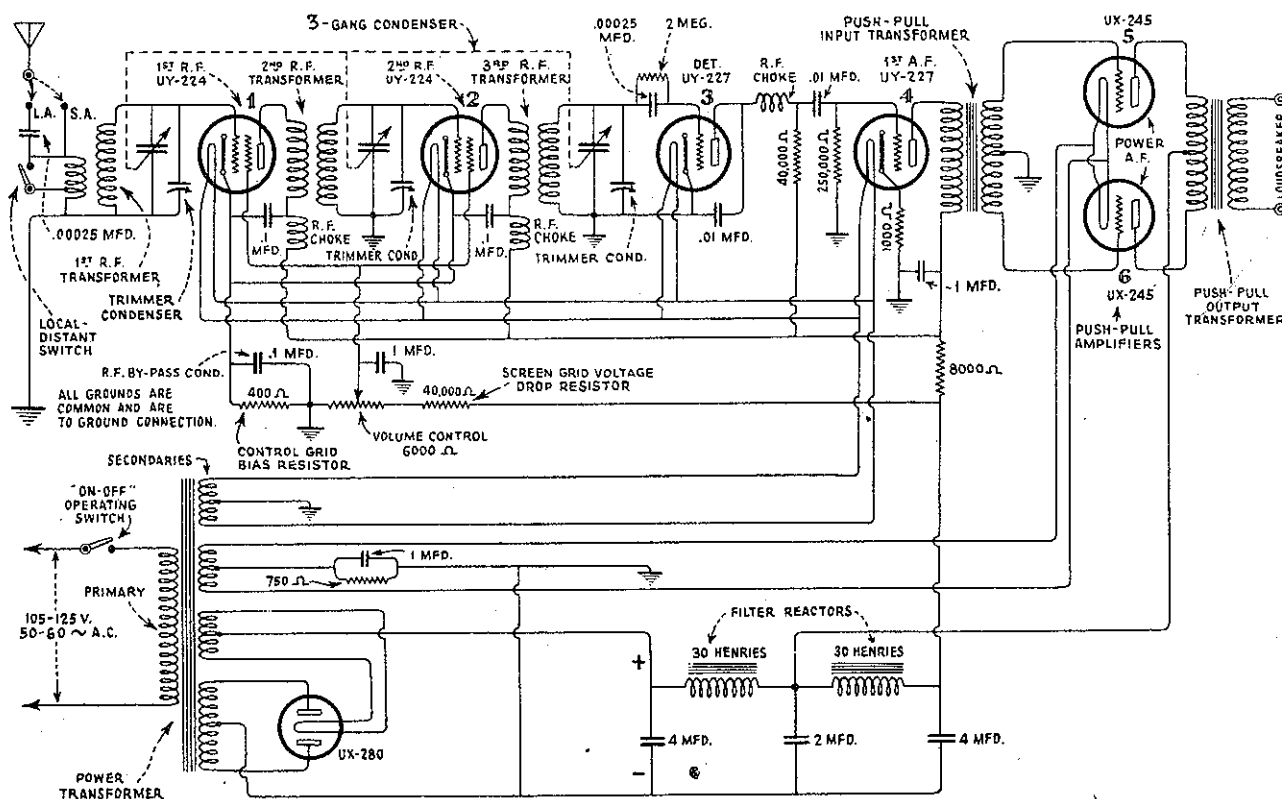


Figure 3

Special attention should be directed toward the radio-frequency transformers. There are three r-f transformers two of which are exactly similar in appearance when looking at the individual coils on the outside and inside tubing. Notice that two of the transformers have primary windings that are practically as long as the secondaries, which are wound on the outside tubing. Note that the primary is wound on the inside tubing and the secondary on the outside tubing. The other transformer which is different has a short primary coil located on the inside tubing but its secondary, or outside winding, is the same size as the other secondaries. Be sure to use the

transformer with the short primary (which by the way is tapped) for the antenna input, or 1st r-f transformer and the other two, or the ones with the large primaries, as 2nd and 3rd r-f transformers. Handle these coils very carefully and mount them in their respective locations according to the picture lay-out in Figure 1. The position that each coil should occupy on the board can be determined by the position of the holding bracket with regard to the four terminals. The general arrangement of the windings on the coils and the exact method of connection to the various terminal lugs at the bottom of the tubing are also illustrated in Figure 1 by two small sketches drawn in schematic form.

The internal method of connection for the input and output push-pull transformers, the filter reactors, the condenser block and the power transformer are likewise pictured in Figure 1. From these sketches you can easily visualize just how the circuits are completed through these parts and this will no doubt aid you in understanding the wiring of the set, providing that at the same time you make comparisons with the complete schematic wiring diagram in Figure 3.

The metal shields which cover the three radio-frequency transformers are not to be placed in position until all of the wiring to these transformers has been completed. Note that r-f transformers are often called "r-f coils." Later in this lesson you will be advised just when ground wires are to be soldered to small eyelets in the shields and when the shields are to be placed over the r-f coils and fastened in position.

At the time of wiring each part the student should make frequent reference to Figure 3, which is the schematic diagram of the complete receiver, so that the relation of the physical part to its symbolic representation will be perfectly clear and understandable.

It is quite necessary for anyone engaged in practical radio work to be capable of reading all kinds of circuit diagrams. One never knows when he may be called upon to translate a schematic diagram into a wiring diagram, or vice versa. To do this often requires considerable thought and time, hence, the wiring of this kit and the reading of the various diagrams will afford excellent practice along these lines.

Before actually starting the work turn to your previous lesson dealing with this screen-grid receiver and, also, to the lesson on soldering and review them both so that you may recall as many of the hints and suggestions contained therein as possible. Carefully study the instructions on how to solder and be sure to put them into practice. Good well-soldered joints are essential and the only way that they can be obtained is to use a properly tinned hot iron and to have all of the surfaces that are to be soldered perfectly clean. Heating the connections to be soldered to as high a temperature as possible causes the solder to adhere to the metal and avoids what is known as a cold, or rosin joint. Satisfactory results will be obtained if you use rosin-core solder and thoroughly clean all of the surfaces to be soldered, as we have just mentioned. By carefully following our instructions you will obtain a good mechanical and electrical joint.

You should now be ready to start your wiring. Rubber covered wire and an assortment of different colored wires are furnished with the set, as you know. The rubber covered wire is larger in size than the colored wires. Use the rubber covered wire for the high-current circuits which supply the filaments and heaters, and the colored wires for the remaining circuits according to our suggestions or, if you prefer, you may work up a color scheme of your own.

When you come to adjusting the trimmer condensers note that any type screw-driver may be used since the screws thread into the frame and, thus, are placed at ground potential. The mechanical construction shows that if you raise or lower a screw it causes the thin metal plate over the mica to move.

PART 2

WIRING OF THE FILAMENT AND HEATER CIRCUITS. Refer to Diagram in Figure 4.

It is clearly indicated in Figure 4 where all of the filament and heater wiring should be placed. It is the usual custom to complete the filament and heater circuits of a receiver before any of the other circuits are wired and, therefore, we will also follow this practice.

An examination of Figure 4 shows that all of the filament and heater wiring is of twisted pairs of wire. This method of twisting the wires is absolutely essential so that the magnetic field set up by the alternating current flowing in the wires will be cancelled out for all practical purposes by the action of the field surrounding one wire upon the field around the adjacent wire. At least, it can be said that the field produced by a-c in the filament and heater circuits is reduced to a negligible amount by the twisted-pair wiring since in the modern a-c set we do not hear an objectionable hum in the loudspeaker that would otherwise be caused if inductive effects existed between these wires and other parts.

Now begin by preparing each set of filament and heater leads, first twisting the wires in pairs and then cutting them to a given length. Cut the leads a little longer than the actual distance between the terminals which they will connect so that you may handle them comfortably on the board. After the wires are twisted and cut to length all of the ends should be scraped clean and tinned and finally each one should be soldered in place. Note that either end of a twisted pair may be soldered to either one of the proper terminals on a socket since polarity is no consideration in heaters and filaments when fed with alternating current. As we explained in our lesson preceding this one, the a-c hum is controlled by the circuit design which is principally taken care of by mid-tapping the various windings on the power transformer.

Notice from the diagram, Figure 4, that the heaters of the two r-f amplifiers and detector tube and the filament of the first audio amplifier are all connected in parallel by leads marked on the diagram F-3, F-4 and F-5,

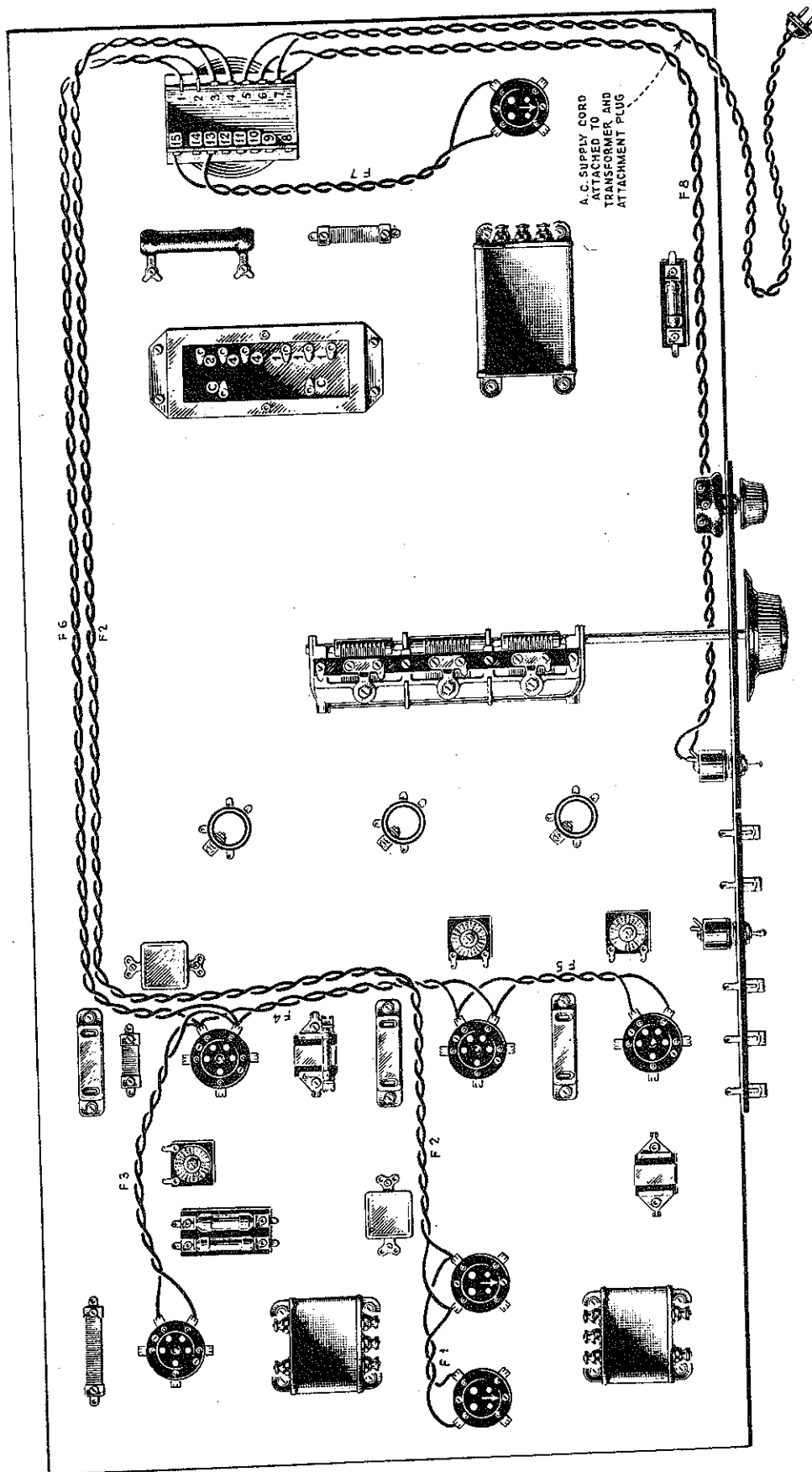


Figure 4

and then by means of lead F-6 they connect to the same winding on the power transformer identified by terminals marked 1 and 2. The center tap of this winding is terminal 8 which connects to ground through wiring to be placed on later.

The filaments of the two 245 power tubes are connected in parallel by lead F-1 and it will be noticed that lead F-2 is run over to terminals 3 and 4 on the power transformer for the voltage supply to these tubes.

If you are satisfied that the wiring thus far has been done correctly you should proceed to wire the filament circuit of the rectifier. The lead F-7 connects the filament terminals on the 280 socket to terminals 13 and 15 on the power transformer; these terminals connect internally to the low voltage winding supplying this tube.

The "OFF-ON" switch is next connected in series with the primary of the power transformer and the a-c line supply cord by the twisted pair marked F-8. The a-c input cord with plug attached connects to terminals 5 and 7 on the transformer.

The wiring of these circuits is now completed and to be certain that they will function normally it is suggested that the following practical test be made with the power on.

1. First, insert the input a-c connection plug in the lighting socket, or the wall outlet as the case may be. Be sure that the required a-c voltage (from 105 to 125 volts a-c) is supplied at a frequency of 50 to 60 cycles. This voltage and frequency are required because of the electrical characteristics of the power transformer.
2. Next, turn the operating switch to the position marked "ON." Be extremely careful not to permit your hands, or any part of your body, to come into contact with the open wiring at the terminal connections. Make it a firm rule never to touch any part of the set, except the controls on the front of the panel, when the power is on.
3. Now insert the rectifier 280 in its socket and, providing the proper voltage is supplied, its filament will light dimly.
4. Now remove the 280 from its socket and insert the tube first in one of the 245 sockets, and then in the other to ascertain whether the circuits are wired correctly. Remember that the 280 tube is placed in the 245 sockets to test the wiring and the indication should be as follows: With the 280 in either of the 245 sockets it should light with much less intensity than when in the 280 socket. If this indication is not obtained and it is found that the tube, when in either of the 245 sockets, lights up brighter or even at the same brilliancy as when in the 280 socket you can assume that the wiring is incorrect for the following reasons, namely:

- (a) Greater brilliancy indicates that the 280 and 245 filament wiring has been reversed. That is, the filament terminals on the 280 socket are connected to the terminals on the power transformer marked to receive the wiring from the 245 socket and vice versa.
- (b) If the 280 lights up with equal brilliancy when in either the 280 or 245 socket it indicates that the 224 and 227 heater wiring and the 280 filament wiring are reversed. That is, the 280 filament terminals on the socket are connected to the transformer terminals which should receive the lead that is carried over to the transformer from the heater terminals on the 224 and 227 sockets. The lead we refer to is marked F-6 on the diagram.

After satisfactorily making the tests explained above, the operating switch is placed in the "OFF" position, the 280 is removed from the set and the plug is pulled out of the lighting socket, or outlet. With this done you are ready to proceed with the wiring of the circuits as outlined in the section immediately following, or PART 3.

Although the wiring of the heater and filament circuits has been explained in detail it will not be necessary to do this throughout all of the work because the different connections are so clearly indicated on all of the diagrams. You cannot go wrong if you are careful in mounting the parts in their proper positions, and follow the wiring diagrams exactly and cut the wires to their proper lengths the first time to avoid waste. Each length of wire can be approximated by holding it in the position that it will finally occupy before cutting it. (The wire should be placed around or between the parts as illustrated)

PART 3

WIRING OF PLATE AND AUDIO-FREQUENCY CIRCUITS. Refer to Diagram in Figure 5.

The wiring diagram in Figure 5 shows all of the leads that must be put in place to connect up the circuits associated with the plates of the receiving tubes and the audio-amplifier portion of the receiver. This wiring is simple to follow and will not require any special instruction other than to observe the suggestions already outlined for accuracy in placing on the leads and care in soldering.

All wires which carry direct current, and this refers to the plate leads of the tubes in the receiver proper, do not require twisting as in the case where a wire carries alternating current like the filament and heater wires, for example, which are made up in twisted-pair. Although the direct current in the plate wires fluctuates according to the modulation of the signal this change in current value is very small and is by-passed by condensers placed at certain positions in relation to the tube circuits. This is the same thing as saying that the r-f, or a-f component of the plate supply, is so small that the field it produces around the wires will not cause any interaction in neighboring circuits and, consequently, all of the plate wires can be placed parallel and close to one another.

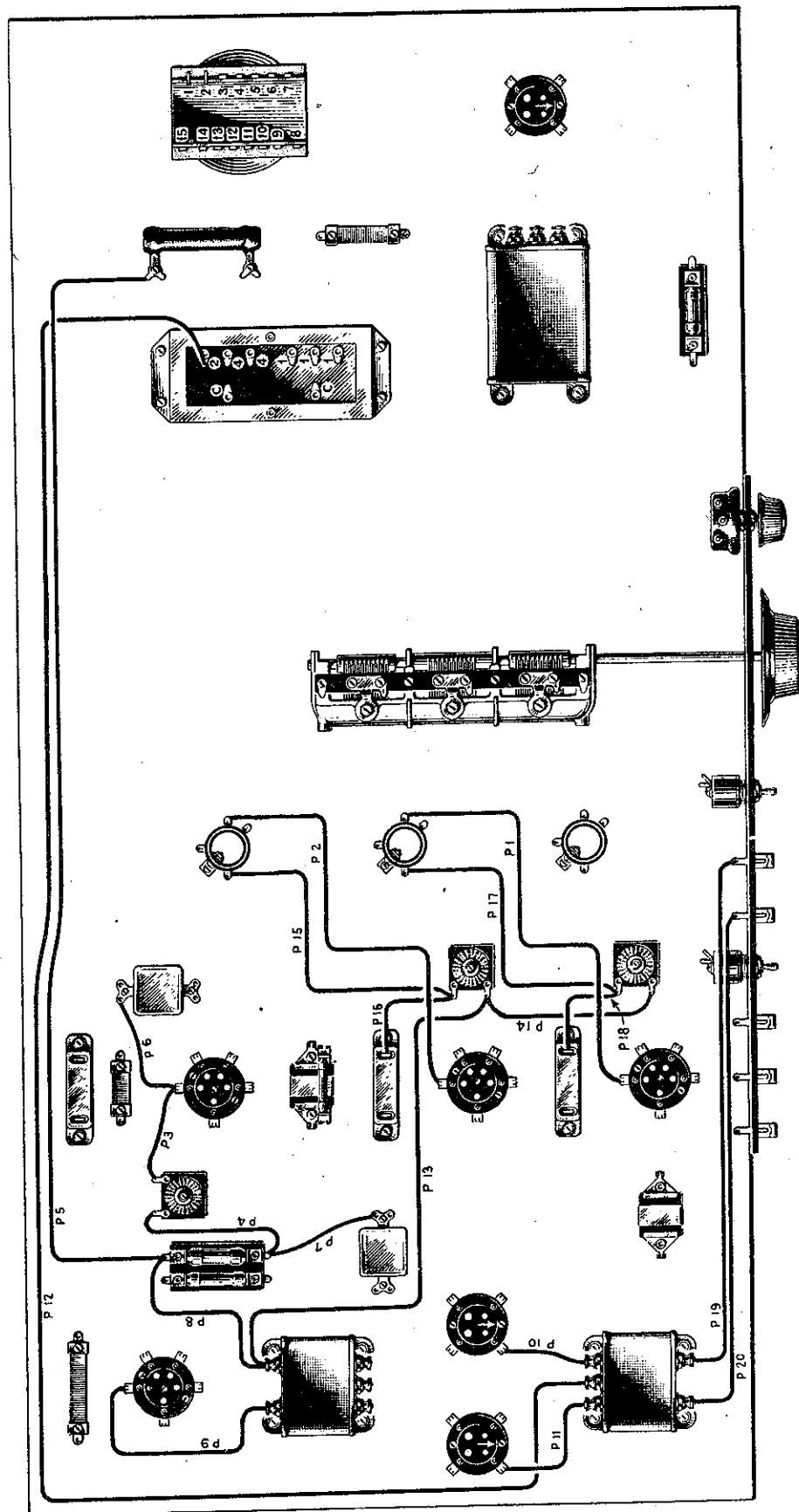


Figure 5

Resistance coupling is used between the output of the detector and the input of the 1st audio-frequency amplifier, whereas, transformer coupling is employed between the output of the 1st audio amplifier and the input of the last audio-amplifier stage, which consists of two power tubes of the UX-245 type arranged in push-pull. The latter type of coupling requires the use of a transformer which has its secondary tapped in the center so that each half of the winding may be connected to a power tube for delivering the signal voltages to the grids of the 245's.

It will prove much easier to study the lay-out if a color scheme is used throughout the main circuits of the receiver as already mentioned. Therefore, let us suggest that you use the red covered wire supplied with the kit for all of the wiring indicated on Figure 5. Another good reason for using red covered wire for these circuits in particular is because in many cases they carry reasonably high voltages and, thus, by using the red color it will serve as a warning for your personal safety to keep clear of such wires when the set is placed in operation. In fact, keep clear of all wiring when the set is active. The wires for this portion of the receiver are marked P-1 to P-20, inclusive, on the diagram.

The large condenser bank containing several condensers with terminals for making connections is sometimes called the capacitor pack. When wiring up this unit bear in mind that the condenser connections within the pack can be easily damaged beyond repair by applying excessive heat at the terminals when soldering on the wires. You must learn not to hold a hot iron too long on a condenser terminal. The length of time must be judged and in general should be just long enough to make the solder flow and adhere to the metal surfaces that are to be joined. This is positively one unit that can be damaged without a person being aware of the fact until it is too late and, therefore, we again warn you to be careful when soldering wires to the condenser terminals. This rule applies to all condensers of the fixed type.

PART 4

WIRING OF THE RADIO-FREQUENCY CIRCUITS, ANTENNA, GRIDS and CATHODES. Figure 6.

The various lengths of wire required to connect up the radio-frequency circuits of the receiver are designated in Figure 6. Let us impress upon you that the radio-frequency circuits are especially critical as to the placing of the wiring and this should be done exactly as we recommend in the diagram. If any of the wires are wrongly located as to their position with regard to other leads and parts it may seriously affect the operation of the set, or result in inability to properly line up the radio-frequency circuits. This work will prove easy if you keep in mind a few very important points dealing with r-f circuits, as follows: Be careful to have all of the r-f grid circuit wiring as short and direct as possible from point to point, or from terminal to terminal, and separated as much as possible from other wires and parts.

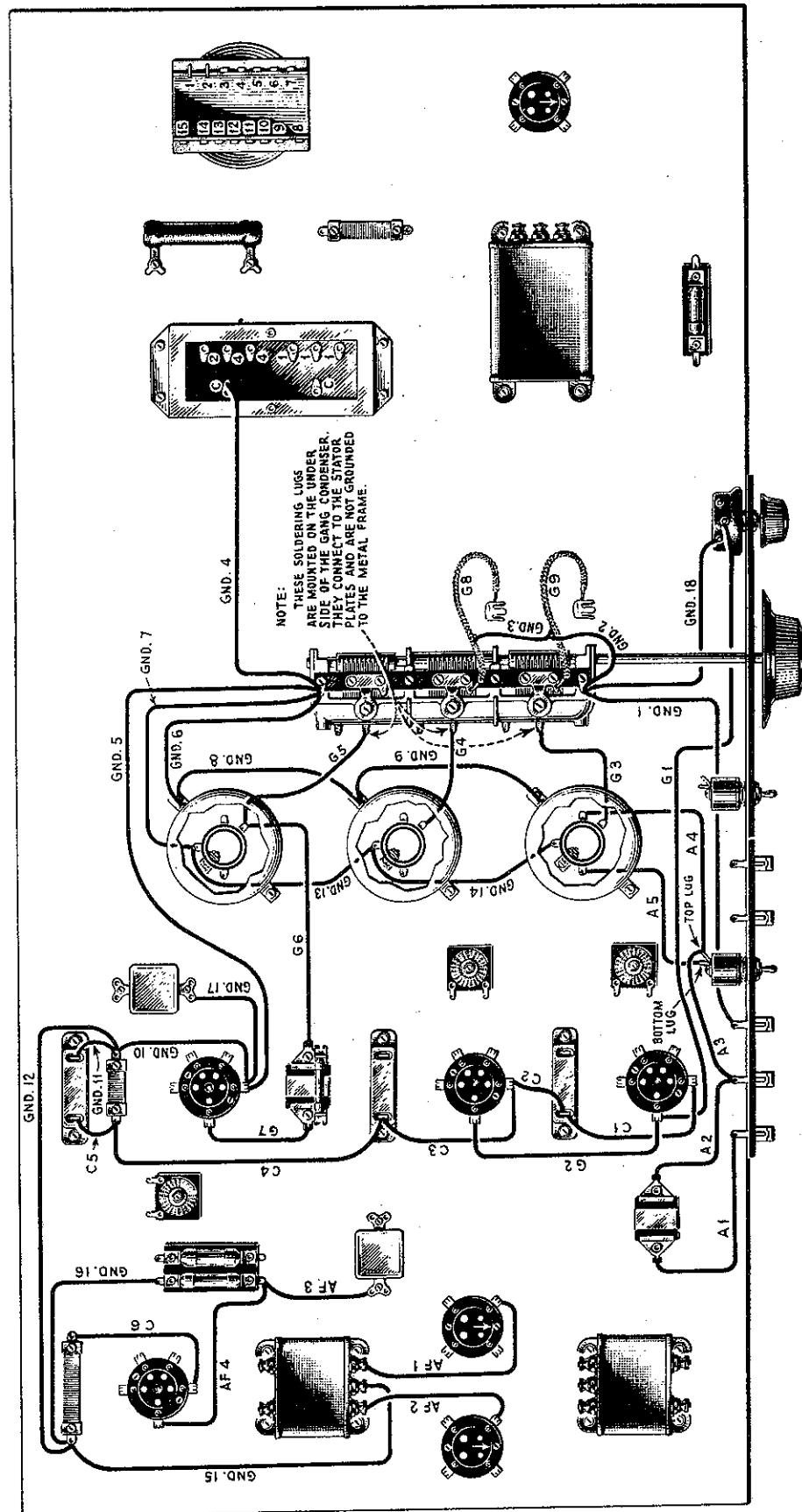


Figure 6

All of the ground connections are to be made at the locations indicated on the drawing. At the time of wiring up the various grounds the shields over the control grid connections should also be grounded. This is another part of the receiver that should be wired with extreme care. The shielding and grounding of the control grid connections must be done correctly, or else the receiver will oscillate when a low value of screen-grid voltage is applied to the radio amplifier tubes.

How to Prepare the Two Shielded Grid Leads. Reference to Figure 7 will show you how to prepare each braided, or shielded wire. Note how the braided strands are cut back allowing at least 1/4" of rubber insulation between the strands and the bared ends of the copper wire itself. Also, how the metal cap, or clip, is soldered to one end and a ground lead to the strands at the opposite end of the shield wire. After each grid lead is completed it is soldered to a particular lug on the top of the gang-condenser. These control grid wires go to the stator plates of the first two condensers, respectively.

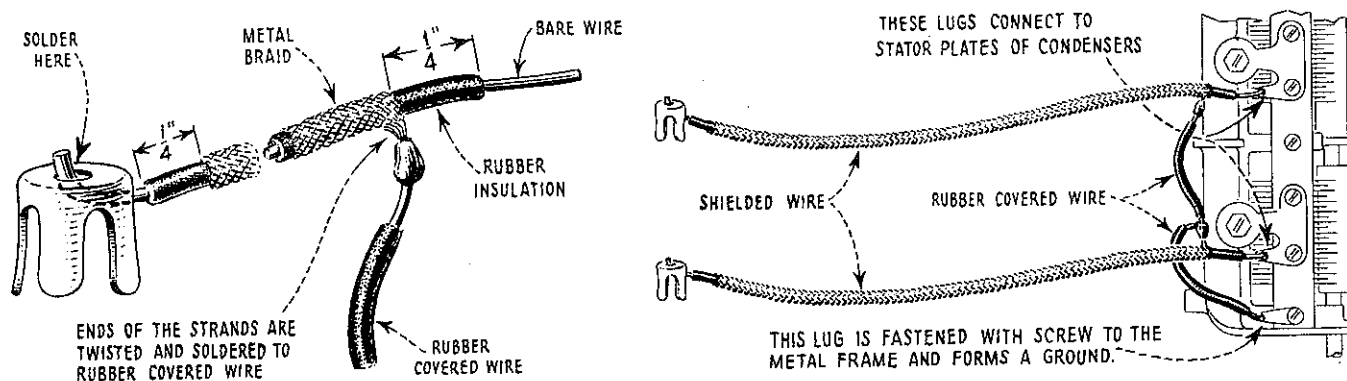


Figure 7

The color of the wires used to connect up the circuits in PART 4 and the marks which identify the individual wires, as shown on Diagram 6, are as follows: The wires used for the antenna circuits are green and are labelled A-1 to A-5, inclusive. The ground leads are black wires and are marked GND-1 to GND-18, inclusive. The cathode wires C-1 to C-6, inclusive, are blue. The grid wires G-1 to G-7, which carry the r-f input voltages to the grids, are yellow. The wires AF-1 to AF-4 are used to supply the grid input to the audio-frequency tubes and these wires are green.

Note that there are three soldering lugs on the bottom of the gang-condenser for making convenient connections at the bottom instead of carrying wires up to the lugs on the top of this unit. Each lug is attached to the stator plates of a tuning condenser.

PART 5

WIRING OF THE POWER SUPPLY CIRCUITS, RECTIFIER AND FILTER. See Figure 8.

The next section of the set to be wired includes the circuits which supply a-c and d-c voltages to the various tubes throughout the set. This section consists of the a-c line supply cord and plug, the power transformer, the rectifier tube and the filter system. There are also three resistors to be wired at the same time, some of these being part of the voltage divider.

The two plates of the rectifier tube are supplied with alternating current from one of the windings on the power transformer. This winding is large and especially designed to give a high output voltage. All other plate circuits in the receiving set are supplied with direct current obtained from the output of the rectifier after the d-c has passed through the filter system. Just follow the wiring diagram carefully and use red colored wires if you wish. The wires for these circuits are marked R-1 to R-17, inclusive.

PART 6

PRACTICAL OPERATION OF THE SCREEN-GRID RECEIVER. See Diagram in Figure 9.

Important Suggestions. After completing the wiring of all the circuits they should be carefully checked. While doing this you must not permit anything to distract your attention, or else you may overlook an error. It is best to place a check on each individual wire of the complete wiring diagram in Figure 9 at the time that you examine this wire on the set itself and in this way you will be assured of having inspected every wire.

It is advisable to check over a circuit of this kind sometime after the construction and wiring have been completed but not immediately after. A very sound practical reason can be advanced for this suggestion. For instance, if you finish your wiring one day wait until the following day to go over the work and then do it slowly. Never attempt to check when you are tired or fatigued for it is invariably in such circumstances that one will make omissions, or errors which are difficult to locate at the time. If you will exercise a little patience and wait until the next day the whole lay-out of the receiver will take on a different appearance to you; in fact, the relation of the parts and circuits in general will be much clearer to you than at the time when you were concentrating on the placing of the many wires in their proper positions. In a few words, it could be said that in any form of work mistakes are more quickly and easily found a day after the completion of the actual work.

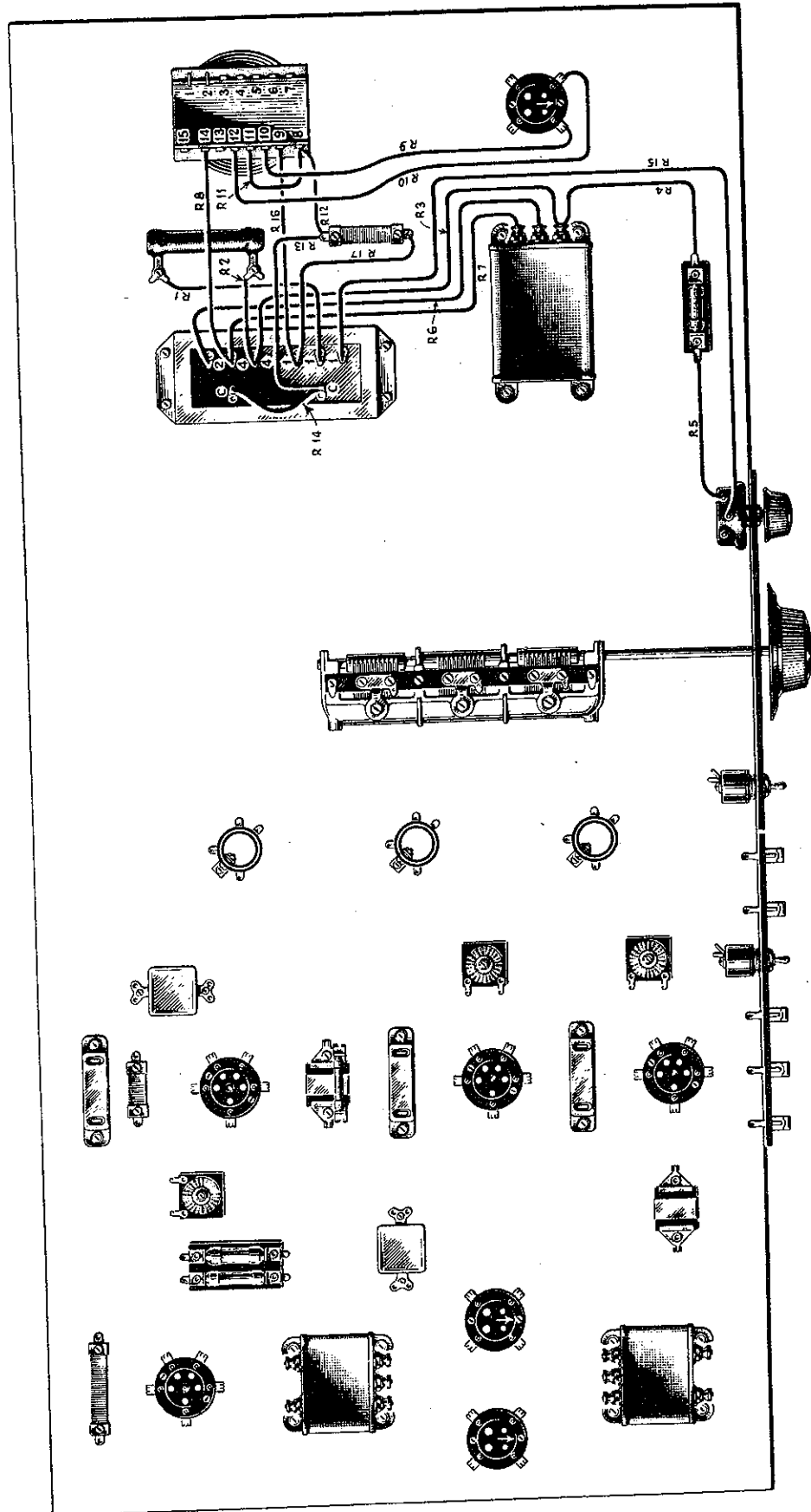


Figure 8

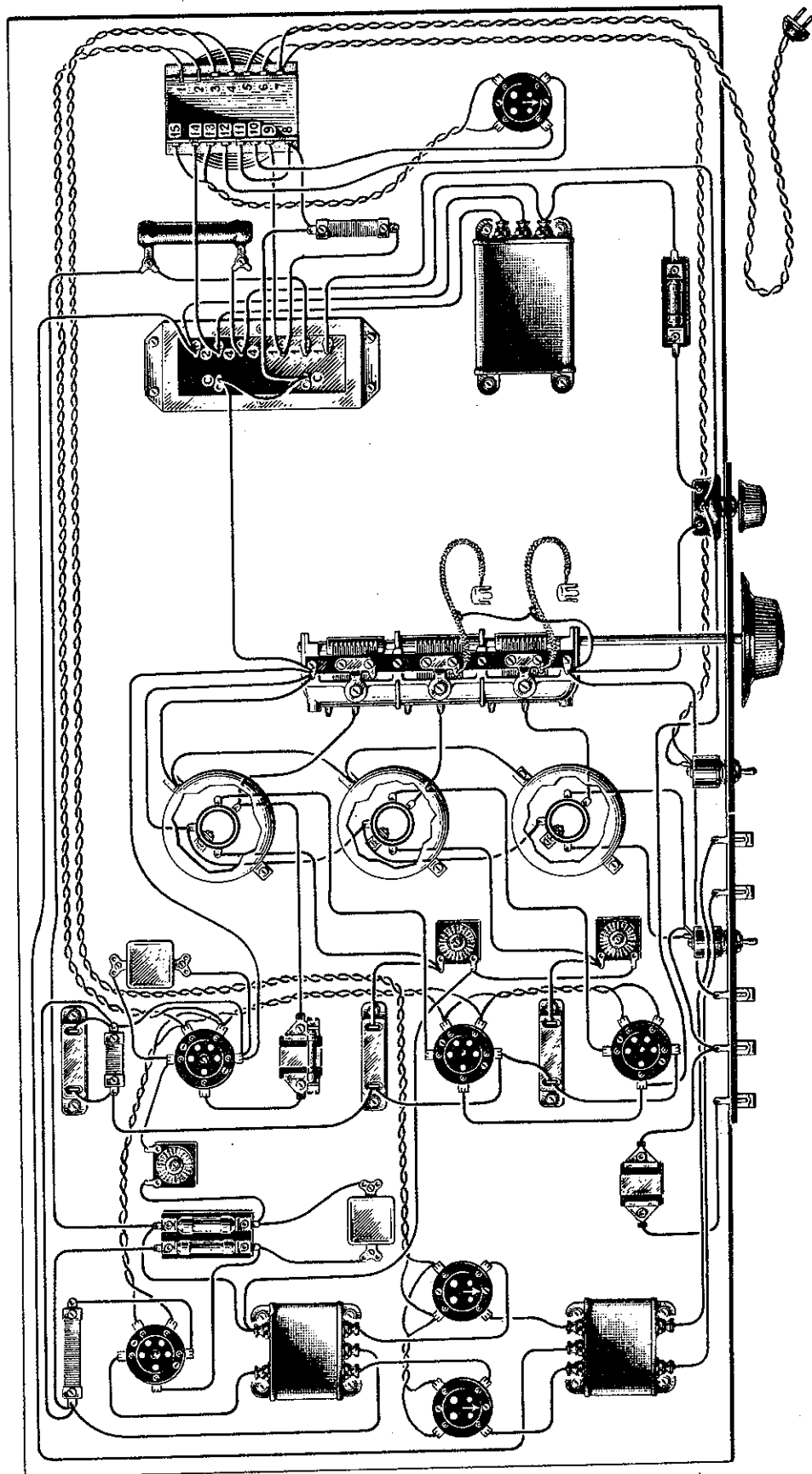


Figure 9

The facts related in the preceding paragraphs hold equally true for all kinds of engineering and manufacturing work and, in large organizations, the work of an individual is usually rarely ever checked by the same person who performed the work.

After all of the wires are in place you should again refer to the complete wiring diagram in Figure 9 for the purpose of ascertaining the different wires that can be cabled together to improve the appearance of the set. You should use a piece of strong cord, or fish line of sufficient length, and lace wires which run parallel with one another for any distance in the form of a cable. The improvement in the appearance of the receiver is not the only feature involved in lacing wires together in this manner, but by doing so tends to prevent any possible trouble in the future due to misplacement of leads. Do not lace in any wires which connect to the grids of tubes, in a cable form with other wires.

When the wiring has been completed according to the main wiring diagram and all of the work has been gone over and inspected again for cold-soldered joints, rosin joints, and correct wiring, then it is time to place the radio-frequency shield cans in their proper positions. Each of the ground terminals on the shields are connected together and then one lead is run from the shield nearest the rear of the set to the ground lug located on the metal frame of the gang-condenser. The final ground connection is made with a wire running from a ground lug on the gang-condenser to the "GND" terminal on the terminal strip.

PLACING THE SET INTO OPERATION. The receiver is now ready for operation and applying power from the a-c mains. Follow the procedure given below to place the set in operation:

- (a) First connect the loudspeaker cords to the two output terminal connections on the terminal strip marked "SPEAKER."
- (b) Connect the antenna and ground leads to their respective terminal connections, also on the same strip.
- (c) Insert the tubes in their proper sockets according to the picture diagram of the set in Figure 1 which shows the relative position of the sockets and the types of tubes to be used in each. Place each shielded wire clip on the metal cap on top of a 224 tube. This wire forms the connection to the control-grid and is the wire through which the signal energy passes. It is important that the two UX-245 amplifier tubes be closely matched to insure good reproduction.
- (d) Be sure that the operating switch has been in the "OFF" position during this time. Now insert the plug attached to the electric cord from the power transformer in the lighting socket of the a-c supply, or any convenient outlet in the house-lighting system.
- (e) If you do not already know the voltage and frequency of the a-c supplied to your premises make inquiry from the district office of the electric company to ascertain if

the alternating current is of proper voltage and frequency for your set, that is, 105 to 125 volts a-c at a frequency of 50 to 60 cycles.

- (f) Now turn the operating switch to the "ON" position and place the "LOCAL DISTANT" switch in the "DISTANT" position. Power is now on the receiver circuit and it will require a brief interval for the tubes to warm up. Turn the volume control about half way to the left and begin adjusting the "Station Selector," which is another name for "Tuning Dial." At some position on the dial, as it is rotated slowly across the scale, a signal should come through from some station whose transmitting frequency is within the range of your receiver, or the broadcast range, as we commonly refer to it. It might be added that as you advance the volume control to the right, to increase volume, a slight sound might be heard which indicates that the set has gone into oscillation. This is a normal condition. Oscillation, providing it is set up, will occur only when the volume control is at or somewhere near the upper end of the volume control range. Remember that the point of maximum sensitivity of the receiver is just below the point where oscillation is set up and, therefore, when the set is in this condition it is extremely sensitive.

PART 7

LINE-UP ADJUSTMENTS OF THE RADIO-FREQUENCY CIRCUITS. Diagram Figure 1.

Each of the tuned radio-frequency circuits are balanced, or placed in resonance with one another, by means of a small variable condenser, the capacitance of which can be altered very easily by a simple adjustment. A condenser used for this purpose is called a "trimmer" condenser, or "line-up" condenser, and is connected in parallel to the main tuning condenser of the r-f circuit.

The small line-up condensers in your set are located on the top of the 3-gang condenser assembly. Notice the position of the three screws, and that each one connects to a condenser. By turning the screw one way or the other the distance between the plates of the condenser is changed, either made greater or less, and in this way the condenser's capacitance is varied. Let us again repeat that the three small condensers are connected in parallel to the main tuning condensers and their purpose is to compensate for any lack of agreement in resonance between the three r-f circuits which might be due to slight variations in parts, or wiring, of the r-f amplifier. It is absolutely necessary to have the three r-f circuits in exact synchronism throughout the 180 degrees of their tuning range before the receiver can operate with maximum sensitivity or selectivity.

The procedure for synchronizing the r-f circuits is as follows:

- (a) Tune in a station whose frequency is not less than 1200 kilocycles but preferably 1400 or 1500 kilocycles. If you already possess a modulated oscillator this may be used in place of an actual broadcast signal since the

oscillator sends out a note having a modulation of uniform character. A modulated oscillator can be constructed very easily according to the circuit diagram and constants of the parts as shown in Figure 10. If you intend to do very much testing and adjusting of receivers it will repay you to build a modulated oscillator because it can be used any time and at any place in the absence of a radio signal and, moreover, the audio modulation of an oscillator of this type is of uniform character as just stated. Its use enables one to make more satisfactory adjustments.

- (b) Now tune in the signal carefully from the broadcasting station, or from the modulated oscillator, and adjust the trimmer condenser connected with the r-f circuit of the detector. The screw for this condenser is the last one toward the rear of the gang condenser. The screw should

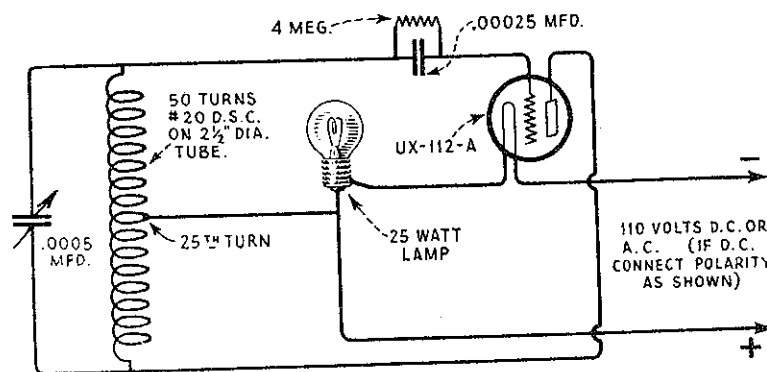


Figure 10

be turned either one way or the other until a maximum value of signal is obtained from the loudspeaker. Make this adjustment carefully because it is very critical.

- (c) Next adjust the trimmer condenser attached to the tuning condenser associated with the 2nd r-f amplifier stage. The screw for this adjustment is the middle one of the three and it should be turned until the signal comes in loudest in the same manner that the detector trimmer condenser was adjusted.
- (d) This time the trimmer condenser associated with the 1st r-f amplifier is adjusted for maximum signal strength in precisely the same way as in the case of the other two trimmer condensers. The screw adjustment for this condenser is the first one toward the front of the gang condenser.

- (e) It is recommended that the adjustments be gone over carefully a second time in order to check up the work and any further changes that are considered necessary should be made at this time.
- (f) After the second set of adjustments have been made the line-up of the three r-f circuits should be correct and the receiver ready for efficient operation. It is important that these adjustments be made with the "LOCAL-DISTANT" switch in the "DISTANT" position. There are no other adjustments required for this receiver except those you have just made for synchronizing the r-f circuits. Normal operation of the set should be obtained upon satisfactory completion of this work.

SUMMARY. If the receiver fails to operate after all of our instructions have been carried out specifically, or if it operates but gives abnormal results, then the trouble is possibly due to a mistake in the wiring, a defective tube, or loudspeaker cord, or speaker, or some one of the parts in the set may not function. Since every part furnished in the kit is carefully tested before shipment you should exert every effort to find the trouble before assuming that the cause of failure is in one of the parts. Go over the set again and recheck the wiring and heat all soldered joints again to make certain that the electrical connections are good and finally check the antenna system and tubes if trouble is experienced.

A good antenna system can be constructed according to the instructions given in our lesson on this subject.

EXAMINATION - LESSON 33

1. Why are filament and heater wires made up in twisted-pair?
2. What is the principal difference between the 1st r-f transformer and those used in the 2nd and 3rd r-f stages?
3. What precaution should be made when soldering leads to the terminal lugs of small fixed condensers?
4. What are trimmer condensers used for?
5. Explain how you would line up the radio-frequency stages in the receiver.
6. When getting a set of tubes together for the receiver should you be particular in any way about the two 245 tubes used in the push-pull amplifier stage and why?
7. What is the "LOCAL-DISTANT" switch used for?
8. How is the volume of your set regulated?
9. In general what are the advantages of a screen-grid set?
10. How is control grid bias obtained for the screen-grid tubes in your set?